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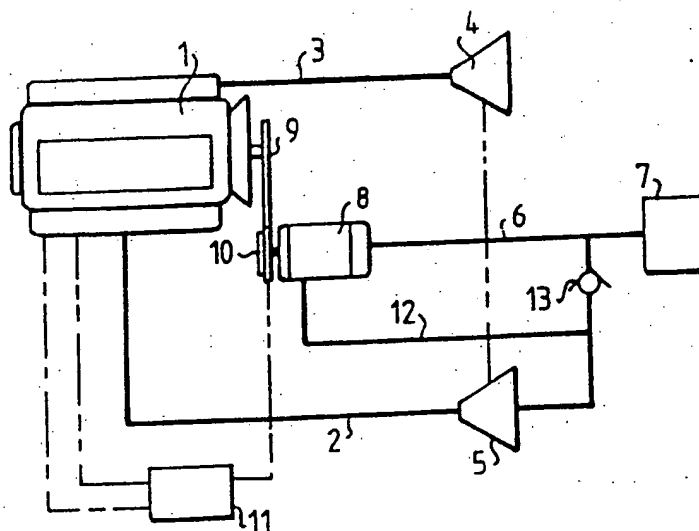
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## (57) Abstract

The invention relates to a supercharged internal combustion engine (1) with a mechanical compressor (8) and a turbo-compressor (4, 5), which are coupled in series. The turbo-compressor is coupled downstream of the mechanical compressor. Between the connection (12) of the latter with the suction side of the turbo-compressor and the air intake (7) of the turbo-compressor, there is a non-return valve (13) arranged, which opens towards the turbo-compressor when the air requirement of the turbo-compressor exceeds the capacity of the mechanical compressor.

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Supercharged internal combustion engine

The present invention relates to a supercharged internal combustion engine comprising an exhaust driven turbo-compressor and a compressor mechanically driven by the engine, the pressure side of said compressor being connected to the suction side of said turbo-compressor, and means for suspending the effect of the mechanical compressor on the supercharging of the engine.

It is a known fact that a supercharged diesel engine with a high average pressure always has the disadvantage that its torque at low and medium r.p.m. is low. In order to obtain high power, the turbo unit must be optimized towards high boost pressure in the high r.p.m. range, which has the effect that the boost pressure will be relatively low in the lower r.p.m. range, since the available exhaust energy within this range is often insufficient to drive the turbo unit. This in turn leads to higher exhaust emissions, primarily in the form of soot and particle formation, and low torque with resulting poor acceleration. The problem becomes especially pronounced in heavy planing boats, which have a complicated resistance curve. Under certain conditions, for example in heavy seas running head on, it can be difficult to push the boat over its planing threshold.

It is known e.g. by US-4 258 550 to compensate the relatively poor boost pressure of a turbo compressor at low r.p.m. with a mechanically driven compressor which is coupled in series with the turbo-compressor as described by way of introduction, i.e. the pressure side of the mechanical compressor is connected to the suction side of the turbo-compressor. This produces a boost pressure on the pressure side of the turbo-compressor which is a result of the combined effect of the two compressors. In the known system disclosed in said patent specification, a pair of valves are arranged which are switched over when sufficient charge

pressure can be achieved with the turbo-compressor alone so that the pressure side of the mechanical compressor is connected to a charge air cooler for the turbo-compressor at the same time as the turbo-compressor's suction side is reconnected from the pressure side of the mechanical compressor directly to an air intake.

The purpose of the present invention is in general, starting from the above mentioned known series coupling of a mechanical compressor and a turbo-compressor, to achieve a supercharged internal combustion engine of primarily diesel type, in which the charge pressure can, with simple means, be optimized for the high r.p.m. range as well as the low and medium r.p.m. ranges. In particular, it is intended to provide a supercharged diesel engine particularly suited to heavy planing boats, which provides sufficient propelling force even in the lower r.p.m. range, within which the boat is to overcome its planing threshold.

This is achieved according to the invention in a supercharged internal combustion engine of the type described by way of introduction by virtue of the fact that said means comprise valve means arranged between the connection point of the mechanical compressor to the suction side of the turbo-compressor and the air intake of the turbo-compressor, said valve means being disposed to be kept closed as long as the amount of air delivered by the mechanical compressor is greater than the air requirement of the turbo-compressor, and to open when the air requirement of the latter exceeds the capacity of the former.

By making the air requirement of the turbo-compressor one of the parameters controlling the interaction between the compressors, it is possible to achieve a relatively simple and inexpensive installation. In the simplest embodiment, said valve means can be formed by a simple mechanical non-return valve, which automatically opens towards the suction side of the turbo-compressor when the pressure on said side drops below the pressure on the air intake side of said

valve. In a further development of the invention, the valve can cooperate with control means which disengages a clutch arranged between the engine and the mechanical compressor when the valve opens.

The invention will be described in more detail with reference to examples shown in the accompanying drawings, of which Figs 1 and 2 show schematically two diesel engines representing two different embodiments of the compressor system.

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In Fig 1, 1 designates an internal combustion engine of diesel type, 2 the engine intake conduit and 3 its exhaust conduit. A turbo-compressor, consisting of a turbine portion 4 and a compressor portion 5, is connected in the conventional manner in the intake conduit 2 and the exhaust conduit 3. The intake conduit 2 is branched from a conduit 6 between an air filter 7 and the suction side of a compressor 8 mechanically driven by the engine 1. This can be of any known type at all, but preferably of displacement type, e.g. a screw compressor, which is driven directly by the engine crank shaft via a V-belt transmission with the general designation 9.

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Furthermore, there is an electromagnetic clutch 10 between the drive shaft of the mechanical compressor 8 and its belt pulley. The engagement and disengagement of the clutch is controlled by an electric control unit 11, into which signals are fed representing engine r.p.m. and load (marked by dash/dot lines in Fig 1). The pressure side of the compressor 8 is coupled via a conduit 12 to the intake conduit 2 upstream of the turbo-compressor but downstream from a mechanical non-return belt 13, which can be of any suitable known type, e.g. a valve with a closing element in the form of a spring-biassed flap.

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The engine installation described functions as follows:

When the engine 1 is at idle, the magnetic clutch 10 is disengaged and the compressor 8 is thus at rest. As the

throttle is slowly opened, with accompanying slow increase in r.p.m., the mechanical compressor 8 is engaged at a predetermined r.p.m., for example ca 1500 r.p.m. The engagement is thus dependent on r.p.m. when the throttle is  
5 opened slowly and the load increases slowly. If, however, signals indicating a sharp increase in load, at an engine speed below the engagement r.p.m., are received by the control unit 11, the mechanical compressor 8 is engaged earlier so that the required charge pressure is always  
10 obtained.

At increasing load on the engine 1, the turbo-compressor 4,5 will assume a larger and larger proportion of the total charged pressure, and when the turbo-compressor requires more  
15 air on the suction side than what the mechanical compressor is able to deliver, the non-return valve 13 will open automatically since the pressure downstream of the non-return valve 13 will then be less than the pressure on the air filter side. The mechanical compressor 8, after the non-  
20 return valve is opened, will have no function and in order to reduce the energy consumption of the engine and noise as well as reduce wear to the compressor 8, this should be turned off at this stage. This can also be effected via the control unit by storing a predetermined turn-off r.p.m., for example 3.000  
25 r.p.m., in the control unit or via signals to the control unit indicating that the non-return valve is open.

In Fig 2, an engine installation is shown which differs from that described above only as regards the valve means and  
30 their control. Components corresponding to those in Fig 1 have been given the same reference numerals as in Fig 1. Instead of a simple mechanical non-return valve, the valve is in the form of an electrically operated on-off valve 14 arranged in the intake conduit 2. The turning on and off of  
35 the valve 14 is controlled by the control unit 11 in response to signals from a pair of pressure sensors 15 and 16, respectively, on the suction and pressure sides, respectively, of the mechanical compressor 8. The control unit is thus disposed to open the valve 14 when the signals

sent to the control unit by the pressure sensors 15,16 indicate that the pressure on the suction and pressure sides are equal. These signals are also used to simultaneously turn off the mechanical compressor.

Claims

1. Supercharged internal combustion engine, comprising an exhaust-driven turbo-compressor and a compressor mechanically driven by the engine, the pressure side of said compressor being connected to the suction side of said turbo-compressor, and means for suspending the effect of the mechanical compressor on the supercharging of the engine, characterized in that said means comprise valve means (13;14) arranged between the connection point of the mechanical compressor (8) to the suction side of the turbo-compressor (4,5) and the air intake (7) of the turbo-compressor, said valve means (13;14) being disposed to be kept closed as long as the amount of air delivered by the mechanical compressor is greater than the air requirement of the turbo-compressor, and to open when the air requirement of the latter exceeds the capacity of the former.
2. Engine according to Claim 1, characterized in that said valve means are formed by a non-return valve (13), disposed to open towards the suction side of the turbo-compressor (4,5) when the pressure on said side drops below the pressure on the side of the valve facing the air intake (7).
3. Engine according to Claim 1, characterized in that said valve means are formed of an on-off valve (14), which, via control means (11) is coupled to pressure sensors (15,16) on the suction and pressure sides of the mechanical compressor (8) and which is arranged to open when the pressures on the suction and pressure sides are equal.
4. Engine according to any one of Claims 1-3, characterized in that the mechanical compressor (8) is driven by the engine via a clutch (10) which can be turned on and off, and that said valve means (14) cooperate with the control means (11), which disengage the compressor when the valve means open the connection between the suction side of the turbo-compressor and the air intake.



5. Engine according to anyone of Claims 1-4, characterized in that the mechanical compressor (8) is of displacement type.
5. 6. Engine according to anyone of Claims 1-5, characterized in that the engine (1) is a marine diesel engine.

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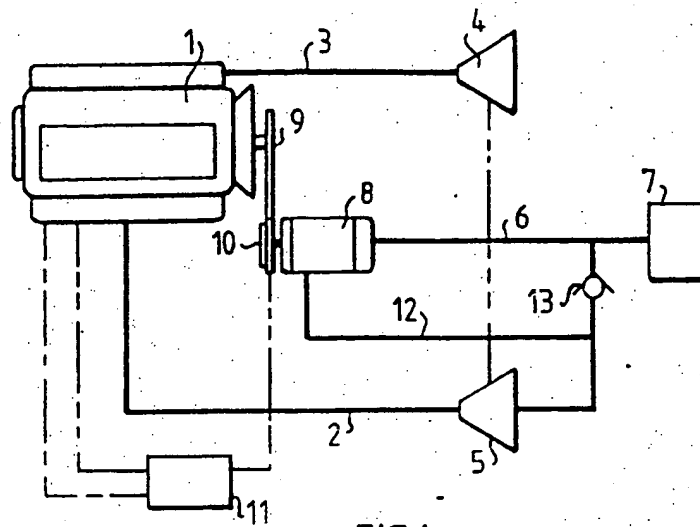


FIG.1

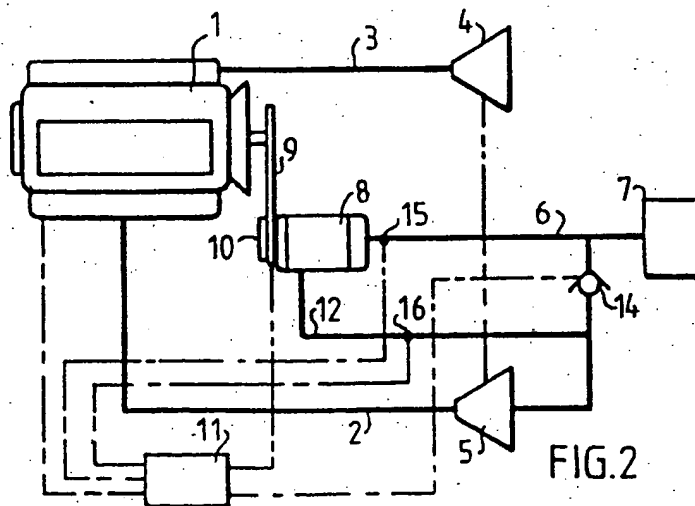
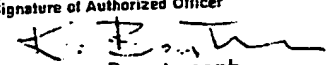


FIG.2

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/SE 91/00584

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>1</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: F 02 B 37/04</b>		
<b>II. FIELDS SEARCHED</b> Minimum Documentation Searched <sup>2</sup>		
Classification System	Classification Symbols	
IPC5	F 02 B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched <sup>3</sup>		
<b>SE,DK,FI,NO classes as above</b>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>4</sup></b>		
Category <sup>5</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	US, A, 4258550 (HINKLE ET AL) 31 March 1981, see the whole document	1-6
A	US, A, 3595013 (M.G. BRILLE ET AL) 27 July 1971, see the whole document	1-6
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<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
9th December 1991	1991-12-10	
International Searching Authority	Signature of Authorized Officer	
SWEDISH PATENT OFFICE	 Krister Bengtssonh	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 91/00584**

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4258550	81-03-31	CA-A- 1128762	82-08-03
		GB-A-B- 2051232	81-01-14
		JP-C- 1372859	87-04-07
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US-A- 3595013	71-07-27	DE-A-B-C 1903261	69-10-16
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		GB-A- 1262138	72-02-02
		NL-A- 6901730	69-08-11
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